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How to form a Basal Magma Ocean? Insights from two-phase thermo-dynamical numerical modeling

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In 2007, Labrosse et al. [1] have proposed that the sparse ultra low velocity zone observed at the base of the Earth's mantle, and generally interpreted as patches of dense partial melt [2], could be the vestiges of a basal magma ocean once overlying the core mantle boundary.
To investigate the physical mechanisms involved in the formation of such a basal magma ocean, we have designed a two-phase flow model describing the early mantle of the Earth as a mixture of melt and viscously deforming solid matrix. More specifically our model takes into account (i) the compressibility of melt with depth and the melting of the matrix via a coupling source term, (ii) the phase change (melting/solidification), (iii) two-phase viscous dissipation.
Because of its compressibility and iron content the melt eventually becomes denser than the surrounding matrix [3]. Consequently, above this critical density cross-over depth, the melt is percolating upwards to form a magma ocean at the surface while symmetrically below this depth it is migrating downward to form a basal reservoir.
Meanwhile the rocky matrix deforms as well inducing compaction and thermal adjustment. When the two phases are present, temperature is fixed to the melting temperature (solidus and liquidus are equal in our model) and surficial cooling induces the rapid solidification of surficial magma oceans whereas corresponding basal magma oceans last longer.

References

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